# CONSUMPTION OF

# FRESHWATER FISH BY MAINE ANGLERS

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## 1.0 INTRODUCTION

The State of Maine will be establishing an ambient water quality standard for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Due to the physical and chemical properties of TCDD that influence its environmental fate and transport, the consumption of fish is the primary route of human exposure to TCDD found in aquatic environments. Therefore, the estimation of a representative rate of fish consumption from Maine waterways is critical to the derivation of a scientifically-based and health protective water quality standard for TCDD in the State of Maine.

Published studies that specifically investigate or estimate freshwater fish consumption in Maine are nonexistent. The fish consumption data that are available in the scientific literature are based on national surveys or are specific to other regions of the country (Rupp et al., 1980; Humphrey, 1978; Parsons et al., 1991; Puffer et al., 1971; Pierce et al., 1971; Javitz, 1980; Honstead et al., 1971.). Consequently, the use of these data to estimate the consumption habits of Maine residents may be inappropriate. Many surveys have not adequately characterized the types of fish consumed (EPA, 1989a). Other studies are limited because they report total consumption but make no distinction between the consumption of commercially-harvested and recreationally-harvested fish (Javitz, 1980; EPA, 1989a). The most frequently used estimates of fish consumption are of limited use for estimating freshwater fish consumption from Maine rivers because they are either based on marine studies (Puffer et al., 1981; Pierce et al., 1981) or include a combination of both saltwater and freshwater species and do not consider the sources of the fish consumed in the diet (Javitz, 1980; EPA, 1989a). Furthermore, the use of freshwater fish consumption studies from one region of the U.S. may overestimate or underestimate the consumption of freshwater fish in another region of the country (Rupp et al., 1980). The differences in preferred species, availability, access, length of fishing season and cultural heritage greatly influence freshwater fish consumption in a particular region.

The best example of a generic criterion is the 6.5 grams per day (g/day) estimate used by the EPA in developing Ambient Water Quality Criteria (AWQC) for various chemicals (EPA, 1984). This value was developed on the basis of national per capita fish consumption and included all commercially-harvested and recreationally-caught freshwater and estuarine fish and shellfish (EPA, 1989a). Therefore, the EPA criterion is not an applicable estimate of the rate at which people eat Maine freshwater fish.

The purpose of this study was to characterize the rates of freshwater fish consumption by Maine residents. In contrast to other areas of the country (e.g., the Pacific Northwest), Maine's freshwater fish species are not commercially marketed. Consequently, the only dietary source of local freshwater fish is recreational fishing. Only those individuals who fish, or who share in the catch of other anglers, consume freshwater fish caught in Maine's waters.

Creel surveys are frequently used to estimate angler use and fish harvest from particular waterbodies. To this end, two creel surveys, designed to characterize fish consumption habits of anglers on two of Maine's rivers, have recently been completed (ChemRisk, 1991a; 1991b). However, because individual anglers may fish in a number of different locations, creel surveys on specific waters may not completely characterize total freshwater fish harvest or consumption for those individuals and others sharing in their catch.

Because of the limitations associated with creel surveys, a statewide mail survey of licensed Maine anglers was undertaken to more completely identify total freshwater fish consumption by Maine's residents. This study was modeled on earlier surveys, conducted on behalf of the Maine Department of Inland Fisheries and Wildlife (IFW) (Boyle et al., 1989; Phillips et al., 1990) and targeted recreational anglers and their families because they would potentially be the highest consumers of freshwater fish in the State.

A number of surveys have been conducted over the last few years in order to characterize the fishing habits of Maine's resident and non-resident anglers (Boyle et al., 1989; Phillips et al., 1990; Boyle et al., 1990). Although these surveys have been useful in establishing trends in angler use, catch, and harvest, they were not designed to characterize final disposition and consumption of the fish. Consequently, this current survey was designed to expand upon the earlier work and make it possible to determine how much of the catch is consumed per angler per day. The overall survey design follows the well-established and effective survey methods used in previous IFW surveys.

## 2.0 METHODS

Survey Design

The survey design was based on consultation with Mr. Owen Fenderson, a fisheries biologist with the Maine IFW Planning Division, with considerable experience in fisheries planning and management; Dr. Kevin Boyle and Dr. Stephen Reiling, resource economics specialists at the University of Maine in Orono; and Mr. Edward Spear, a consulting fisheries biologist with many years of fisheries management and creel survey experience. HBRS, Inc. of Madison, Wisconsin provided expertise in survey design and implemented the mail survey.

The survey design team agreed that the target group should be resident recreational fishermen and their families. In order to select the minimum sample size necessary to ensure statistically valid results, the most constraining piece of data was identified and the sample size was calculated to ensure that the minimum number of replies required for statistically valid results would be received.

To determine sample size, the following logic was used, based on the results of previous fishing surveys (Boyle et al., 1989; Phillips et al., 1990):

- More anglers fish standing bodies of water (e.g., lakes and ponds) than fish flowing waters (e.g., rivers and streams). Therefore, flowing waters were targeted.

- More anglers fish for coldwater species than for warmwater species. Therefore, warmwater species were targeted.

- Because perch are the warmwater species with the lowest participation rate (percent anglers seeking to catch perch) for which consumption data were desired (Boyle et al., 1989; Phillips et al., 1990), this species was targeted.

Multiplying the inverse of the participation rates for perch harvested from warm water riverine fisheries by the desired number of consumption observations for perch (100) resulted in the conclusion that it was necessary to receive 1,363 completed surveys.

To determine the minimum sample size required to obtain these 1,363 completed surveys, the expected proportion of undeliverable surveys and the response rate of anglers who received a survey were estimated. The sample population consisted of individuals holding a valid Maine residential fishing license in 1989. Non-resident anglers were not included as previous surveys indicated that non-resident anglers, on average, spend substantially fewer days fishing in Maine than do residents and would, therefore, consume less Maine fish (Boyle et al., 1989; Phillips et al., 1990). Based on their previous experience in conducting mail surveys in Maine, Boyle and Reiling estimated that, at best, only 90 percent of the mailed surveys would actually be received by anglers. Because the sample population was based on 1989 license data, it was projected that an additional 10 percent of the surveys would be either undeliverable (changes in address or deaths) or not answered due to changes in fishing status between 1989 and 1990. In addition, it was assumed that approximately 75 percent of the fishermen who received the survey would complete and return it. Using these assumptions, a required minimum sample size of approximately 2,244 was calculated using the following equation:

$$Ts = \frac{Tr}{Pd_1 \times Pd_2 \times R} \qquad (1)$$

where:

Ts = Total number of surveys sent

Tr = Total required for a statistically valid sample size (1,363)

$Pd_1$ = Fraction of surveys deliverable as addressed (0.90)

$Pd_2$ = Fraction of 1989 licensed anglers who also purchased 1990 licenses (0.90)

R = Expected response rate to delivered surveys (0.75)

Because of uncertainties about the response rate and the proportion of undeliverable surveys, it was decided that 2,500 surveys should be mailed.

Respondent Selection Process

Maine fishing licenses are issued annually and are valid from January 1 through December 31 of a given year. An individual fishing license permits an angler to ice fish or open water fish during the legal season at the specific waters being fished.

The names and addresses of 2,953 Maine residents holding valid 1989 fishing licenses were selected from the files at the offices of the IFW in Augusta, Maine. Additional names were included as a precaution against any difficulties in conducting the survey (illegible handwriting, incomplete addresses, etc). Because it was believed to be important to mail the survey as close to the end of fishing season as possible in order to minimize difficulties in recall, and because IFW license files for 1990 were incomplete at the time of respondent selection, names were obtained from the complete 1989 IFW fishing license files. This same approach has been used by Boyle et al. (1990) in their surveys conducted on behalf of Maine IFW. Licenses were selected randomly from the following resident categories: fishing; combination archery and fishing; combination hunting and fishing; serviceman combination; and supersport. In order to randomly select anglers from the entire adult fishing population, complimentary licenses from the following categories were also included: over age 70 - combination; over age 70 - fishing; paraplegics - combination; paraplegics - fishing; disabled veterans - combination; disabled veterans - fishing; blind - fishing; mental disability - fishing; and Indian - combination. Because complimentary licenses are renewed every three years, licenses from the 1987-1989 pool were used in the retrieval process.

Based on a sampling population of 225,000 license holders and a goal of approximately 3,000 randomly selected names, every 75th license holder was selected from the resident and complimentary files. After approximately 3,000 names were selected, all of the pertinent mailing information for each selected angler was entered into a computer database and sent to HBRS, Inc. for their use in the mailings.

Trial Survey and Refinement

A pretest of the survey was conducted in order to evaluate whether questions contained in the survey were understandable to respondents. An advance letter, followed by the pretest version, was mailed to 50 fishermen who held 1989 Maine resident fishing licenses. Both the advance letter and the cover letter included with the pretest version of the survey informed the recipients that HBRS was designing a survey to learn more about fishing habits in the State of Maine. The respondents were asked to fill out the survey but not return it until October 5, 1990. Prior to this date, recipients were contacted by telephone and asked if they had any difficulties in filling out the questionnaire, and if there were any questions that were difficult to understand or answer. Telephone interviews were completed with 20 (40 percent) of the pretest participants. Based on

the telephone interviews, a review of the returned pretest surveys, and changes suggested by Boyle, Reiling, Spear, and Fenderson, final revisions to the survey were made.

Survey Implementation

Two thousand five hundred individuals were sent an advance letter on October 9, 1990, to notify them that a survey was being mailed and to present a brief explanation of the importance of the survey (Appendix A). The survey package was mailed on October 16, 1990 along with a cover letter explaining the study (Appendix B), a question and answer sheet to address some of the questions that people might have (Appendix C), a survey (Appendix D), and a stamped, self-addressed, return envelope. If a survey packet came back as undeliverable, another packet was sent to the individual if the post office was able to provide a new address for that individual. On October 23, 1990 a "thank you/reminder" postcard (Appendix E) was mailed to each recipient, thanking those who had already returned the survey, and asking those who had not yet returned the survey to do so. On November 7, 1990 a follow-up survey packet was mailed to 1,111 non-respondents. The packet was identical to the initial packet, except that the accompanying cover letter (Appendix F) asked the recipient to complete and return the survey by December 3, 1990.

Compilation of the Data Set

1,612 completed surveys were returned to HBRS, Inc., thus exceeding the targeted response goal of 1,363. Data entry was conducted by HBRS, Inc. using a numerical coding scheme for recording responses to each question in the mail survey. Data editors reviewed each returned survey and used this coding scheme to translate survey responses into numeric values. After each returned survey was edited, the numeric values were entered into a data base using the SPSS/PC (V3.1) + Data Entry II Program (SPSS, 1989). To verify that all data were entered correctly, each completed survey was entered twice and the results compared. After all of the returned surveys were entered and verified, response frequencies were constructed for each survey question as a final check for data entry accuracy. This final data set was provided to ChemRisk as a fixed-format computer file with a separate template file.

Selection of Critical Questions

Several critical questions were identified for meeting the goals of (1) limiting the analysis to those individuals who fished or who consumed fish caught from Maine waters in 1990, and (2) differentiating between consumption estimates of fish caught in all water bodies and consumption of fish caught in flowing waters.

Estimating fish consumption required determining the total fish mass that was consumed by the total number of reported freshwater fish consumers in the respondent's household. Questions 11, 24, 29, and 31 were designed to determine the amount of fish consumed (Appendix D). Question 11 asked how many fish of each of 14 named species (with space available to enter the name of and information about any other species) were caught during the ice fishing season and eaten. This question also asked the respondent to indicate the average length of the fish eaten. Question 24 asked for the same information about fish caught during the open water fishing season, and asked the respondent to differentiate between fish caught from standing waters (e.g., ponds and lakes) and from flowing waters (e.g., rivers and streams). Question 29 targeted information about consumed fish that were caught in Maine by other members of the respondent's household. Question 31 asked about additional fish consumed within the angler's household that were caught by persons outside of the household.

In selecting species to be included in the survey it was decided that Atlantic salmon and smelt would be included in the freshwater fish consumption rate for Maine's rivers. Atlantic salmon are anadromous fish that do not feed in freshwater but only enter the rivers to spawn. The same is true for smelt. There are two types of smelt in Maine: freshwater lake smelt and marine smelt. Both types enter Maine's rivers for brief periods to complete their spawning runs. Like the Atlantic salmon, they do not feed during this period. Although neither Atlantic salmon nor smelt are riverine fish, it was decided to include them in order to characterize consumption of all fish obtained from Maine river systems.

Data from Questions 4, 29, and 31 produced the angler population of interest for data analysis. To include the maximum available data on fish consumption, the population of interest was defined as all respondents who fished in either the 1989-1990 ice fishing or 1990 open water fishing seasons, and all respondents who did not fish in either season, but consumed Maine fish caught by either another member of the respondent's household or by someone outside the respondent's

household. Question 4 asked whether the respondent fished in either the 1989-1990 ice fishing or 1990 open water fishing seasons. 352 respondents did not fish in either season. Response to Questions 29 and 31 indicated that 109 of these 352 respondents did consume freshwater fish from other Maine sources. These 109 respondents were included in the population of interest for a total of 1,369 angler households.

Because an ice fishing season may include the end of one calendar year and the beginning of the next calendar year, all ice fisherman would be required to purchase two separate licenses if he or she fished for the entire ice fishing season. As it was believed that ice fisherman would be likely to recall the season as a whole rather than just that portion covered by their 1990 licenses, anglers were asked about the entire 1989-1990 ice fishing season. For the purposes of this analysis, it was assumed that frequency and success of ice fishing trips in the late Fall and early Winter of 1989 would be representative of trips to be taken in the late Fall and early Winter of 1990. Therefore, to avoid duplication, anglers were not asked to estimate ice fishing trips planned for the late Fall of 1990.

Question 32 was designed to collect information about the number of freshwater fish consumers in the respondent's household. The respondent was asked to provide the age and sex of each member of his or her household and to indicate which members were consumers of recreationally caught freshwater fish.

Because some Maine waters are open to fishing after September 30, it was believed to be important to estimate fish consumption from any fishing trips planned for after the date the survey was completed. Question 25 asked the respondent whether he or she planned to make any future fishing trips under his or her 1990 license and Question 25A asked how many future trips were planned. Questions 8, 14, and 18 were used to determine the number of reported fishing trips each angler made to ice fishing, standing water, and flowing water locations. The total number of reported trips was calculated for each angler, as was the ratio of trips to flowing waters to trips to standing waters and ice fishing locations. Future consumption from all waters and from flowing waters was estimated by assuming that consumption from future trips would be directly proportional to reported consumption from completed trips.

Estimating Fish Consumption Rates

1. Length-Mass Relationship

Respondents were asked to report the average length, by species, of the fish they caught and retained for consumption. In order to estimate the total fish mass consumed by each respondent's household, it was necessary to characterize the relationship between fish length and mass. This was accomplished by use of the standard length to mass relationship (Cone, 1989):

$$W = C \times L^n \qquad (2)$$

where

W = Mass of whole fish
C = constant (species-specific)
L = Length of whole fish
n = constant (species-specific)

Equation (1) can also be expressed as a linear regression based on logarithms (Nielsen and Johnson, 1984; Cone, 1989):

$$\log (W) = C + n \, \text{Log} (L) \qquad (3)$$

This form of the length-mass relationship has recently been cited as most the most appropriate means by which to estimate the length-mass relationship (Cone, 1989). The parameters C and n are species-specific constants. The exact value of n is dependent on the shape of the fish; however, it usually approximates 3 (Nielsen and Johnson, 1983). In general, a value less than 3 represents a fish that decreases in girth as its length increases, while a value greater than 3 is representative of fish species for which girth increases as the fish grows longer (Nielsen and Johnson, 1983). The exact value of each parameter is affected by several variables including season, sex of the fish, sexual maturity, age of the fish, and the type of waterbody in which the fish resides. Due to this wide range of variability, the relationship for a particular species in a given river, lake, or stream is most precisely determined by site-specific sampling and measurement. Because this survey encompassed fishing sites on all rivers, streams, lakes, and ponds throughout the State of Maine, direct measurement was unpractical. Therefore, acceptable

estimates were obtained from Maine-specific data and published literature values (Carlander, 1969; 1977).

For this study, logarithmic regression equations specific to the state of Maine were obtained (unpublished data, MeIFW, 1990). The equations were derived from length and mass measurements compiled over several years from numerous rivers and lakes in the state of Maine. For the species for which these equations were available, these equations are the best available generalized length-mass relationships for Maine (Personal communication, J. Trial, 1991). However Maine-specific equations were not available for all species of interest. For those species for which Maine-specific equations were not available, the most appropriate relationship was selected from those reported in the available literature (Carlander, 1969; 1977). The selected equations and discussion of the methodology used for their selection are presented in Appendix G.

2. Consumed Mass

The total mass of freshwater fish consumed by each respondent's household was estimated from the respondent-provided information on quantity and average length of each consumed fish species. The equation used to estimate the mass of freshwater fish consumed from ice fishing sources is presented below:

$$IMC = QI_i \times 10^{\{C_i + n_i \log (LI_i \times f)\}} \times EP_i \qquad (4)$$

where:

$IMC_i$ = Total mass of freshwater fish species i consumed by angler and household from Maine ice fishing sources (g)

$QI_i$ = Quantity of fish species i consumed from Maine ice fishing sources;

$C_i$ = Constant in length/mass relationship for species i (log g)

$n_i$ = Slope in length/mass relationship for species i (log g/log mm)

$LI_i$ = Average length of consumed freshwater fish species i from Maine ice fishing sources (in)

f = conversion factor (25.4 mm/in)

$EP_i$ = Fraction of whole fish mass that is edible for species i (g consumed/g whole fish)

To apply this equation, it was necessary to characterize the relationship between the mass of a whole fish, and that portion considered to be edible. The EPA (1989b) recommends that 30 percent be used to estimate the edible portion of finfish. Specific studies were undertaken to determine the edible portion of smallmouth bass and landlocked salmon in Maine (Ebert, 1991a). In these studies, the edible portion was defined as being synonymous with fillet size. Although it is recognized that a number of fish species may not be filleted, overall the use of fillet data is a reasonable estimator for the edible portion of the fish.

It was observed that smallmouth bass collected from the Saco River in southwestern Maine had a mean edible portion of 29 percent of whole fish mass (Ebert, 1991a). A mean edible portion of 30 percent was measured in smallmouth bass collected from the West Branch of the Penobscot River (West Branch) in the north central region of the state (Ebert, 1991a). Landlocked salmon collected from the West Branch showed a mean edible portion of 37 percent (Ebert, 1991a). Based on recommendations by EPA (1989b) and the results of the Maine-specific studies (Ebert, 1991a), conservative edible portions of 40 percent for landlocked salmon and Atlantic salmon and 30 percent for all other species except smelt were selected to estimate consumable mass.

For smelt, a higher edible portion estimate of 78 percent was used. Selection of this higher multiplier was based on the knowledge that some smelt consumers eat all but the head of the fish, while others do not eat the viscera or the head. While it is unlikely that this occurs for the larger marine smelt variety, there are sufficient anecdotal reports to indicate that many consumers of lake smelt use this method of consumption. In order to estimate the edible portion size for these fish, data on weights of head and weights of viscera, recorded during the analyses of landlocked salmon edible portion (Ebert, 1991b), were used.

The West Branch landlocked salmon data indicated that an average of 32 percent of the whole fish weight was represented by the head and viscera and an average of 13 percent of the total fish weight was the head. Because some smelt consumers eat the viscera and some do not (Personal communication, J.Trial, 1991), it was assumed that roughly half of the smelt were eaten with viscera and half without. Therefore, to estimate edible portion, an average of the values reported in the landlocked salmon studies was used. This resulted in an inedible portion of 22 percent and, thus, an edible portion of 78 percent for smelt.

The freshwater fish mass consumed from ice fishing sources by the angler and his or her household was then calculated as the sum of $IMC_i$ over the fifteen species as follows:

$$IMCT = \text{Sum } (i=1 \text{ to } 15)[IMC_i] \quad (5)$$

where:

IMCT = Total mass of freshwater fish consumed by angler and household from Maine ice fishing sources (g)

$IMC_i$ = Total mass of freshwater fish species i consumed by angler and household from Maine ice fishing sources (g)

Analogous equations were developed for calculating consumption from lakes and ponds, rivers and streams, other household sources, and non-household sources, based on reported quantities and lengths of fish consumed from each of these sources.

For those 88 respondents indicating that future fishing trips were planned, the freshwater fish consumption rate from these future trips was estimated on the plausible assumption that consumption of fish from future trips would be proportional to consumption from trips already completed and reported. The following equation was used to estimate the consumption rate from future trips:

$$MCF = TF \times (IMCT + SMCT + FMCT) \times 1/TR \quad (6)$$

where:

MCF = Total mass of freshwater fish estimated to be consumed from future fishing trips to all Maine waters (g)

TF = Number of future fishing trips planned (trips);

IMCT = Total mass of freshwater fish consumed from Maine ice fishing sources (g)

SMCT = Total mass of freshwater fish consumed from Maine standing water sources (g)

FMCT = Total mass of freshwater fish consumed from Maine flowing water sources (g)

TR = Total reported number of fishing trips to ice fishing locations, standing water, and flowing water (trips)

The average daily freshwater fish reported consumption rate from all Maine sources for individual members of a respondent's household was computed using the following equation:

$$FCA = (IMCT + SMCT + FMCT + HMCT + OMCT + MCF) \times 1/HS \times 1/T \qquad (7)$$

where:

FCA = Freshwater fish consumption from all Maine sources (g/person-day)
IMCT = Total mass of freshwater fish consumed from Maine ice fishing sources (g)
SMCT = Total mass of freshwater fish consumed from Maine standing water sources (g)
FMCT = Total mass of freshwater fish consumed from Maine flowing water sources (g)
HMCT = Total mass of freshwater fish consumed from other household sources (g)
OMCT = Total mass of freshwater fish consumed from other non-household Maine sources (g)
MCF = Total mass of freshwater fish estimated to be consumed from future fishing trips (g)
HS = Number of persons in angler's household reported to consume freshwater fish (persons)
T = Time over which fish was consumed (365 days)

Household size was calculated as the number of persons in the angler's household who eat freshwater fish caught in Maine as reported in Question 32. For this analysis, no distinction was made between adults and children. The mass of fish consumed per household member was then divided by 365 days to yield a per-person per-day fish consumption estimate.

Estimates of freshwater fish consumption from flowing water only were computed using a similar method. Efforts were made to estimate future consumption from flowing water and the portion of other source consumption attributable to flowing waters. The following equation was used:

$$FCF = \{FMCT + (FTR \times MCF) + [(FMCT/(IMCT + SMCT + FMCT)] \times (HMCT + OMCT)\} \times 1/HS \times 1/T \quad (8)$$

where:

FCF = Freshwater fish consumption attributable to Maine rivers and streams (g/person-day)

FMCT = Total mass of freshwater fish consumed from Maine flowing water sources (g)

FTR = Ratio of reported trips to flowing water to all reported trips (trips/trips)

MCF = Total mass of freshwater fish estimated to be consumed from future fishing trips to all Maine waters (g)

IMCT = Total mass of freshwater fish consumed from Maine ice fishing sources (g)

SMCT = Total mass of freshwater fish consumed from Maine standing water sources (g)

HMCT = Total mass of freshwater fish consumed from other household sources (g)

OMCT = Total mass of freshwater fish consumed from other non-household Maine sources (g)

HS = Number of persons in angler's household reported to consume freshwater fish (persons)

T = Time over which fish was consumed (365 days)

Future consumption attributable to flowing waters was estimated by multiplying the result of Equation 6 (MCF) by the ratio of the number of fishing trips reported for rivers and streams (Q18) to the total number of fishing trips reported (Q8+Q14+Q18). The portion of consumption from other household and non-household sources attributable to flowing waters was estimated based on the ratio of reported consumption from flowing water to reported consumption from ice fishing, standing water, and flowing water.

Additional analyses were conducted in an effort to define fish consumption according to both income level and ethnic heritage. Income level groups and ethnic groups were determined based on the responses given in Questions 47, 47A, and 48.

## 3.0 RESULTS

The objective of obtaining at least 1,363 completed surveys was achieved (Table 1). The 1,612 surveys that were completed and returned to HBRS, Inc. represented 64 percent of all surveys issued and 69 percent of all surveys received by anglers. A comparison of the demographics of the respondents to this survey with those of respondents to earlier IFW surveys (Boyle et al., 1990; Phillips et al., 1990) indicates that samples are comparable and representative of Maine's resident angler population (Table 2).

A total of 1,251 respondents reported having fished during either the ice fishing season or the open water season or both. Of the 599 individuals who indicated that they had gone ice fishing, 508 (85 percent) reported having caught fish. Of the 1,127 individuals who went open water fishing, 1,053 reported having fished in ponds or lakes and 741 reported having fished in streams and rivers. A total of 976 individuals (87 percent) reported having caught fish on at least one open water fishing trip during the 1990 season.

Consumption rate estimates are given for five groups of individuals in Table 3. Consumption of fish caught in all types of waterbodies including lakes, ponds, streams and rivers, is designated as "All Waters" whereas consumption of fish from flowing waters only is designated as "Rivers and Streams". Within the "All Waters" category, there are two subgroups identified: "All Anglers", representing the total respondent population of interest and their households, including non-consumers; and "Consuming Anglers", representing fish-consuming angler households only. In addition to the "All Anglers" and "Consuming Anglers" designations within the "Rivers and Streams" category, a third subgroup was identified. This group, designated as "River Anglers" includes survey respondents (consumers and non-consumers) who indicated that they fished on rivers or streams at least once during the 1990 open water season, or who consumed fish attributable to rivers and streams.

Due to the large sample size, statistical analysis was conducted without assuming a distributional model. The consumption rate data were positively skewed and would likely be well-fitted to a lognormal distribution; however, use of a distributional model would mask details of the dataset. Accordingly, the median (50th percentile), 66th, 75th, 90th, and 95th percentiles were calculated by rank to summarize fish consumption rates. These percentiles represent the percentage of the population which consumes fish at a rate less than or equal to the rate reported for each percentile.

**Table 1. Response Summary for Maine Freshwater Fishing Survey**

| | | |
|---|---|---|
| Completed Interviews | | |
| Fished in 1989 - 1990 | 1,251 | |
| Did not fish but consumed Maine fish | 118 | |
| Neither fished nor consumed Maine fish | 243 | |
| | | 1,612 |
| No fishing license in 1989-1990 | | 28 |
| Undeliverable as addressed | | 171 |
| Deceased | | 10 |
| Refusal | | 25 |
| Out of the country | | 1 |
| No Response | | 653 |
| Pretest Sample[a] | | 50 |
| Extra Sample[b] | | 403 |
| Initial Sample Size | | 2,953 |

a Sample used for pretest was not included in final analysis.
b. Extra names selected from IFW files which were not used.

**Table 2. Comparison of Results with Previous Angler Surveys**

| | Survey | | |
|---|---|---|---|
| | Boyle et al., 1989 | Phillips et al., 1990 | ChemRisk, 1991 |
| No. of Surveys Sent | 2,000 | 1,000 | 2,500 |
| Response rate | 77% | 83% | 64% |
| No. who actually fished | 83% | 82% | 78% |
| Average age | 41 | 42 | 44 |
| Ave. household income | $29,400 [a] | $31,300 [a] | $31,125 [a] |
| Average education | High school/some college | High school graduate | High school graduate |
| Percent who ice fished | 49% | 52% | 48% |
| Average number of days spent ice fishing | 12 | 14 | 11 |
| Percent fishing ponds/lakes | 93% | 89% | 93% |
| Average number of days spent fishing on ponds/lakes | 19 | 26 | 15 |
| Percent fishing rivers/streams | 77% | 72% | 66% |
| Average number of days spent fishing on rivers/streams | 13 | 18 | 10 |

a. Weighted average using midpoint of income ranges.

## Table 3. Analysis of Fish Consumption Rates

| | All Waters[a] | | Rivers and Streams[b] | | |
|---|---|---|---|---|---|
| | All Anglers[c] | Consuming Anglers[d] | All Anglers[c] | River Anglers[e] | Consuming Anglers[d] |
| N of Cases | 1,369 | 1,053 | 1,369 | 741 | 464 |
| Median (50th percentile)[f,g] | 1.1 | 2.0 | 0 | 0.19 | 0.99 |
| 66th percentile [f,g] | 2.6 | 4.0 | 0 | 0.71 | 1.8 |
| 75th percentile [f,g] | 4.2 | 5.8 | 0.37 | 1.3 | 2.5 |
| Arithmetic Mean [f] | 5.0 | 6.4 | 1.2 | 1.9 | 3.7 |
| Percentile at the Mean [g] | 79 | 77 | 85 | 82 | 81 |
| 90th percentile [f,g] | 11 | 13 | 2.1 | 3.7 | 6.1 |
| 95th percentile [f,g] | 21 | 26 | 4.4 | 6.2 | 12 |
| Percentile at 6.5 g/day [g,h] | 83 | 77 | 97 | 95 | 92 |

a. "All Waters" based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.

b. "Rivers and Streams" based on fish caught only from rivers and streams in Maine.

c. "All Anglers" includes survey respondents (consumers and non-consumers) who fished during the 1989-1990 ice fishing or 1990 open water seasons as well as those anglers who did not fish but reported consuming freshwater fish caught from Maine sources during those seasons.

d. "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.

e. "River Anglers" is a subset of "All Anglers." "River Anglers" includes survey respondents (consumers and non-consumers) who indicated that they fished on rivers or streams during the 1990 open water season.

f. Fish consumption rates are expressed in g/person-day and are the average consumption per day by freshwater fish consumers in the household. Fish consumption rates under "All Waters" are based on reported consumption from all Maine sources, and estimated consumption during 1990 after the survey was completed. Rates summarized under "Rivers and Streams" are based on reported consumption from rivers and streams, estimated consumption during 1990 after the survey was completed, and estimated consumption from other household and non-household sources attributable to rivers and streams.

g. Calculated by rank without any assumption of statistical distribution.

h. Fish consumption rate recommended by EPA (1984) for use in establishing ambient water quality standard

The median consumption rate for All Anglers from All Waters was 1.1 g/day while the 75th percentile for this group was 4.2 g/day and the 95th percentile was 21 g/day. Median consumption for Consuming Anglers was 2.0 g/day with a 75th percentile of 5.8 g/day and a 95th percentile of 26 g/day. For flowing water, which included only rivers and streams, the consumption rates were lower. The median consumption rate for all anglers, consuming and not consuming, was 0 g/day with a 75th percentile of 0.37 g/day and a 95th percentile of 4.4 g/day. For all River Anglers (including consumers and non-consumers), the median consumption rate was 0.19 g/day with a 75th percentile of 1.3 g/day and a 95th percentile of 6.2 g/day. For Consuming Anglers only, the median consumption rate was 0.99 g/day with a 75th percentile of 2.5 g/day and a 95th percentile of 12 g/day.

Arithmetic mean consumption rates were also calculated for each angler group. The mean consumption rate from all waterbodies for all anglers was 5.0 g/day (79th percentile) while the rate for consuming anglers was 6.4 g/day (77th percentile). For rivers and streams, the mean consumption rate for all anglers was 1.2 g/day (85th percentile), the mean consumption for river anglers has 1.9 g/day (82nd percentile), and the mean consumption for consuming anglers only was 3.7 g/day (81st percentile).

The results of this study indicated that when considering all anglers on all waterbodies, 10 percent of the anglers consumed 90 percent of the freshwater fish consumed. For rivers and streams, the distribution of consumption was more exaggerated: 7 percent of the anglers consumed 93 percent of the fish consumed from Maine's rivers and streams. These findings are similar to those reported by Soldat (1970) who observed that 15 percent of the fishermen surveyed on the Columbia River caught 90 percent of the fish.

A significant finding of this survey is that many anglers do not consume any freshwater fish. Twenty-three percent of all anglers surveyed reported that they consumed no freshwater fish caught in 1990. Fifty-five percent of the river anglers surveyed reported that they ate no freshwater fish during the 1990 season. The distribution of the data indicates that most fishermen consume extremely small amounts of freshwater fish while a very few individuals are high consumers.

The total number of each species of fish consumed by responding anglers from each waterbody type is reported in Table 4. A high percentage of the fish caught were subsequently released. Analysis of reported catch and harvest by individual ice fishermen indicated that only 35 percent of the fish caught were consumed. Only 39 percent of the fish caught during open water fishing were consumed by anglers and their families. These findings are supported by studies conducted by MeIFW (1990) and Boyle et al. (1990). Boyle et al. (1990) reported that 24 percent of anglers fish in "catch and release" designated waters (defined as a zero bag limit, one fish bag limit, or minimum length greater than that established in general fishing regulations) about half of the time. In addition, 80 percent of the anglers surveyed reported that they practiced catch and release in non-designated waters (Boyle et al., 1990). The most frequent reasons given for releasing fish included the size of the fish, undesirability of the species caught, and concern about preservation of fishing resources. Ten percent of the resident anglers surveyed who practice catch and release indicated that they do not eat fish (Boyle et al., 1990).

Appendix H includes histograms for interpretation of the fish consumption results for the general angler population. Histograms illustrate the density of fish consumption rates, or the relative number of individuals having consumption rates falling within specified intervals along the range of observed rates. A lognormal distribution is traced onto the histograms to show where detail would have been sacrificed by choosing this distributional model. Box plots provide a simple graphical summary of the observed fish consumption rates (McGill et al., 1978). The plots show approximately the 25th percentile, the median, and the 75th percentile of the fish consumption rates, all of which are measures of location in a dataset that are resistant to the impact of a few extreme values (Hoaglin et al., 1983). Creating a box plot does not require the assumption of a statistical distribution for the data. A discussion of the interpretation of box plots is provided in Appendix I.

In addition to fish consumption rates for the general angler population, rates were estimated according to ethnic background. Eighty-eight percent of the respondents indicated that they were of Non-Hispanic White ancestry and 9.2 percent of the respondents indicated that they were of Native American ancestry (Table 5). The remaining respondents indicated that they were of either Hispanic (0.2 percent), Asian/Pacific Islander (0.1 percent), African American (0.1 percent), or other (0.2 percent) ancestry. Of the respondents, 2.2 percent did not complete this question (Table 5).

**Table 4. Total Consumption of Freshwater Fish Caught by Survey Respondents**

| Species | Ice Fishing | | Lakes and Ponds | | Rivers and Streams | |
|---|---|---|---|---|---|---|
| | Quantity Consumed | Kg Consumed | Quantity Consumed | Kg Consumed | Quantity Consumed | Kg Consumed |
| Landlocked salmon | 832 | 290 | 928 | 340 | 305 | 120 |
| Atlantic salmon | 3 | 1.1 | 33 | 9.9 | 17 | 11 |
| Togue (Lake trout) | 483 | 200 | 459 | 160 | 33 | 2.7 |
| Brook trout | 1,309 | 100 | 3,294 | 210 | 10,185 | 420 |
| Brown trout | 275 | 54 | 375 | 56 | 338 | 23 |
| Yellow perch | 235 | 9.1 | 1,649 | 52 | 188 | 7.4 |
| White perch | 2,544 | 160 | 6,540 | 380 | 3,013 | 180 |
| Bass (smallmouth and largemouth) | 474 | 120 | 73 | 5.9 | 787 | 130 |
| Pickerel | 1,091 | 180 | 553 | 91 | 303 | 45 |
| Lake whitefish | 111 | 20 | 558 | 13 | 55 | 2.7 |
| Hornpout (Catfish and bullheads) | 47 | 8.2 | 1,291 | 100 | 180 | 7.8 |
| Bottom fish (Suckers, carp and sturgeon) | 50 | 81 | 62 | 22 | 100 | 6.7 |
| Chub | 0 | 0 | 254 | 35 | 219 | 130 |
| Smelt | 7,808 | 150 | 428 | 4.9 | 4,269 | 37 |
| Other | 201 | 210 | 90 | 110 | 54 | 45 |
| *TOTALS* | 15,463 | 1,583.4 | 16,587 | 1,590 | 20,046 | 1,168 |

**Table 5. Ethnic Group Distribution**

| Ethnic Origin | Number of Respondents | % of Angler Population Surveyed[a] |
|---|---|---|
| White, Non-Hispanic | 1412 | 88 |
| Scandinavian | 60 | 3.7 |
| French-Canadian | 305 | 19 |
| Italian | 41 | 2.5 |
| Irish | 215 | 13 |
| Other | 300 | 19 |
| Missing | 534 | 33 |
| Hispanic | 3 | 0.19 |
| Native American | 148 | 9.2 |
| Asian/Pacific Islander | 2 | 0.12 |
| Black | 1 | 0.062 |
| Other | 3 | 0.19 |
| Missing | 36 | 2.2 |

a. Based on total number of respondents.

Due to the low number of respondents reporting either Hispanic, Asian/Pacific Islander, or African American ancestry, there was not a large enough sample to permit a statistically valid analysis of consumption rates within those groups. For all other groups, including an ethnic breakdown of Non-Hispanic Whites, fish consumption estimates were completed (Tables 6a and 6b)

Notched box plots were created for fish consumption rates from all waters and from rivers and streams for each ethnic group (Figures 1 and 2) to determine if there were differences in consumption rates among the ethnic groups. These plots were used to determine whether observed differences among ethnic groups in median fish consumption rates for consuming anglers were statistically significant. Because the 95 percent confidence intervals about the median consumption rates overlap for all ethnic groups, the median consumption estimates are not statistically different among the groups at approximately the 95 percent confidence level (McGill et al., 1978). Additional information on the interpretation of notched box plots is provided in Appendix I.

A similar method was used to summarize fish consumption rates according to annual household income level. Table 7 provides the income levels reported by mail survey respondents.

Fish consumption rates for the various reported income levels were analyzed and compared across income groups. Results of these analyses are presented in Tables 8a and 8b. Notched box plots were also used to evaluate the statistical significance of differences in median fish consumption rates from all waters and from rivers and streams among income groups (Figures 3 and 4). As was observed among ethnic groups, the median consumption estimates are not statistically different among income groups at approximately the 95 percent confidence level.

Table 6a. Analysis of Fish Consumption by Ethnic Groups for "All Waters" [a]

| | Consuming Anglers [b] | | | | | |
|---|---|---|---|---|---|---|
| | French Canadian Heritage | Irish Heritage | Italian Heritage | Native American Heritage | Other White Non-Hispanic Heritage | Scandinavian Heritage |
| N of Cases | 201 | 138 | 27 | 96 | 533 | 37 |
| Median (50th percentile) [c,d] | 2.3 | 2.4 | 1.8 | 2.3 | 1.9 | 1.3 |
| 66th percentile [c,d] | 4.1 | 4.4 | 2.6 | 4.7 | 3.8 | 2.6 |
| 75th percentile [c,d] | 6.2 | 6.0 | 5.0 | 6.2 | 5.7 | 4.9 |
| Arithmetic Mean [c] | 7.4 | 5.2 | 4.5 | 10 | 6.0 | 5.3 |
| Percentile at the Mean [d] | 80 | 70 | 74 | 83 | 76 | 78 |
| 90th percentile [c,d] | 15 | 12 | 12 | 16 | 13 | 9.4 |
| 95th percentile [c,d] | 27 | 20 | 21 | 51 | 24 | 25 |
| Percentile at 6.5 g/day [d,e] | 77 | 75 | 81 | 77 | 77 | 84 |

a. "All Waters" based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.

b. "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.

c. Fish consumption rates are expressed in g/person-day and are the average consumption per day by freshwater fish consumers in the household. Fish consumption rates under "All Waters" are based on reported consumption from all Maine sources, and estimated consumption during 1990 after the survey was completed. Rates summarized under "Rivers and Streams" are based on reported consumption from rivers and streams, estimated consumption during 1990 after the survey was completed, and estimated consumption from other household and non-household sources attributable to rivers and streams.

d. Calculated by rank without any assumption of statistical distribution.

e. Fish consumption rate recommended by EPA (1984) for use in establishing ambient water quality standards.

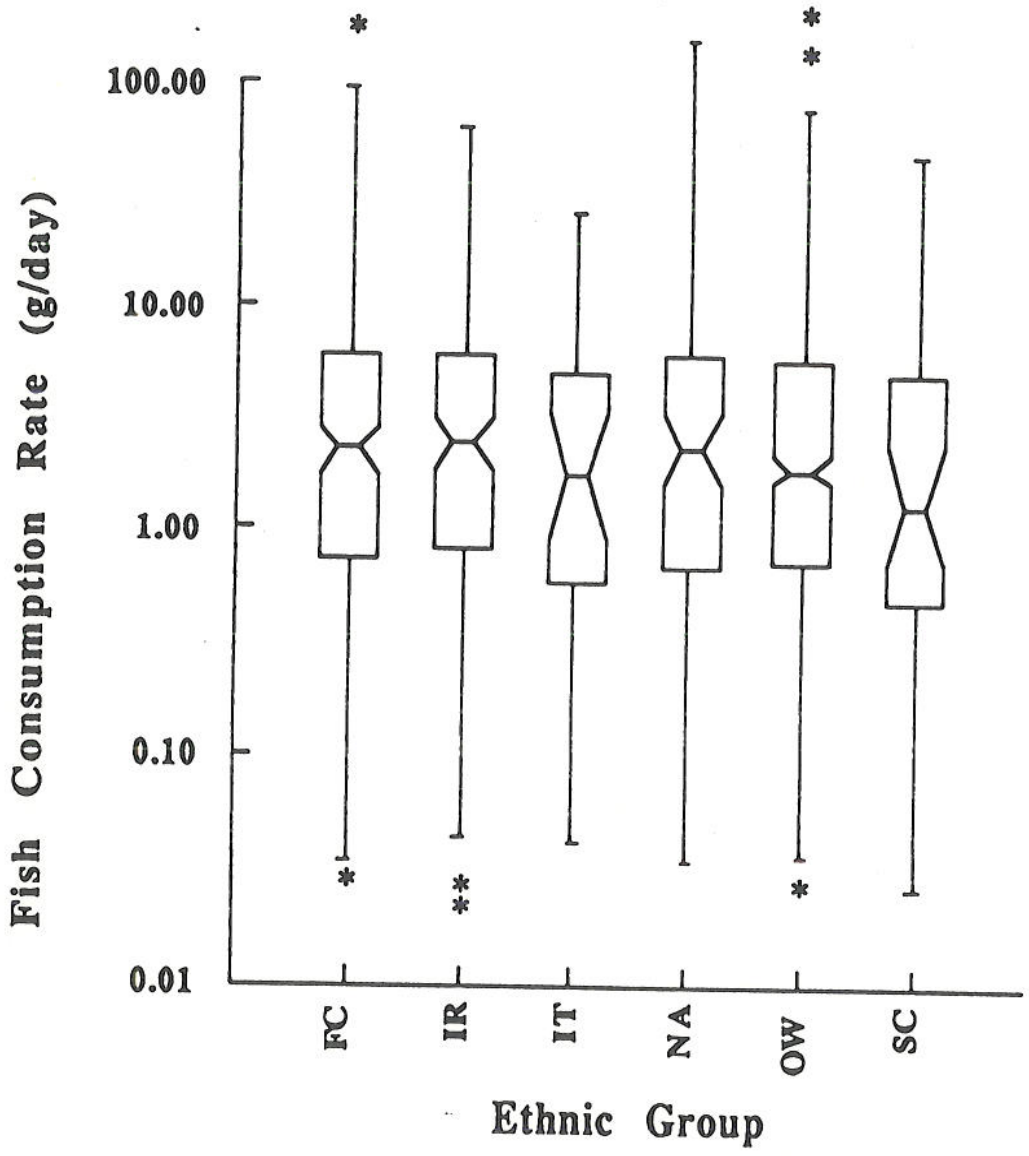
Table 6b. Analysis of Fish Consumption by Ethnic Groups for "Rivers and Streams"[a]

| | Consuming Anglers[b] | | | | | |
|---|---|---|---|---|---|---|
| | French Canadian Heritage | Irish Heritage | Italian Heritage | Native American Heritage | Other White Non-Hispanic Heritage | Scandinavian Heritage |
| N of Cases | 86 | 63 | 10 | 43 | 237 | 14 |
| Median (50th percentile)[c,d] | 0.95 | 1.3 | 1.1 | 0.92 | 1.1 | 0.61 |
| 66th percentile[c,d] | 1.7 | 1.9 | 2.0 | 2.2 | 1.7 | 0.87 |
| 75th percentile[c,d] | 2.5 | 2.8 | 4.2 | 3.7 | 2.4 | 2.1 |
| Arithmetic Mean[c] | 4.3 | 2.2 | 2.2 | 7.8 | 3.3 | 3.4 |
| Percentile at the Mean[d] | 87 | 68 | 70 | 86 | 82 | 79 |
| 90th percentile[c,d] | 5.4 | 5.2 | 5.4 | 9.1 | 6.5 | 5.1 |
| 95th percentile[c,d] | 7.1 | 6.3 | 6.2 | 22 | 14 | 5.1 |
| Percentile at 6.5 g/day[d,e] | 94 | 95 | f | 86 | 90 | 93 |

a. "Rivers and Streams" based on fish caught only from rivers and streams in Maine.
b. "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.
c. Fish consumption rates are expressed in g/person-day and are the average consumption per day by freshwater fish consumers in the household. Fish consumption rates under "All Waters" are based on reported consumption from all Maine sources, and estimated consumption during 1990 after the survey was completed. Rates summarized under "Rivers and Streams" are based on reported consumption from rivers and streams, estimated consumption during 1990 after the survey was completed, and estimated consumption from other household and non-household sources attributable to rivers and streams.
d. Calculated by rank without any assumption of statistical distribution.
e. Fish consumption rate recommended by EPA (1984) for use in establishing ambient water quality standards.
f. Exceeds maximum value for this group.

Figure 1.

# FRESHWATER FISH CONSUMPTION BY ETHNIC GROUPS: ALL WATERS




LEGEND

FC = French Canadian, N=201
IR = Irish, N=138
IT = Italian, N=27
NA = Native American, N=96
OW = Other White Non-Hispanic, N=533
SC = Scandinavian, N=37

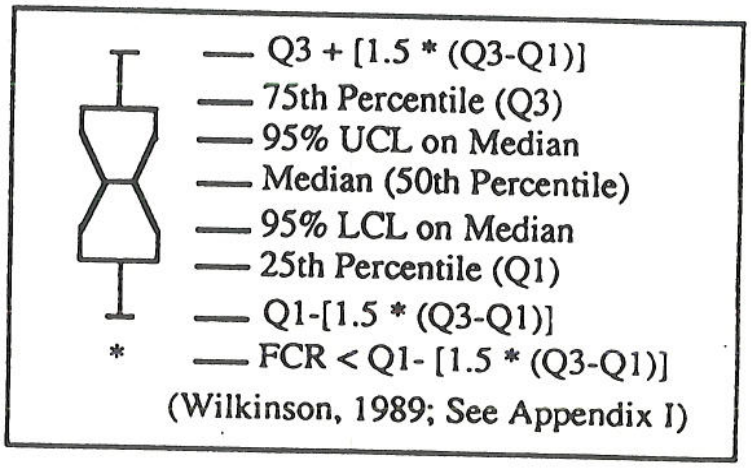
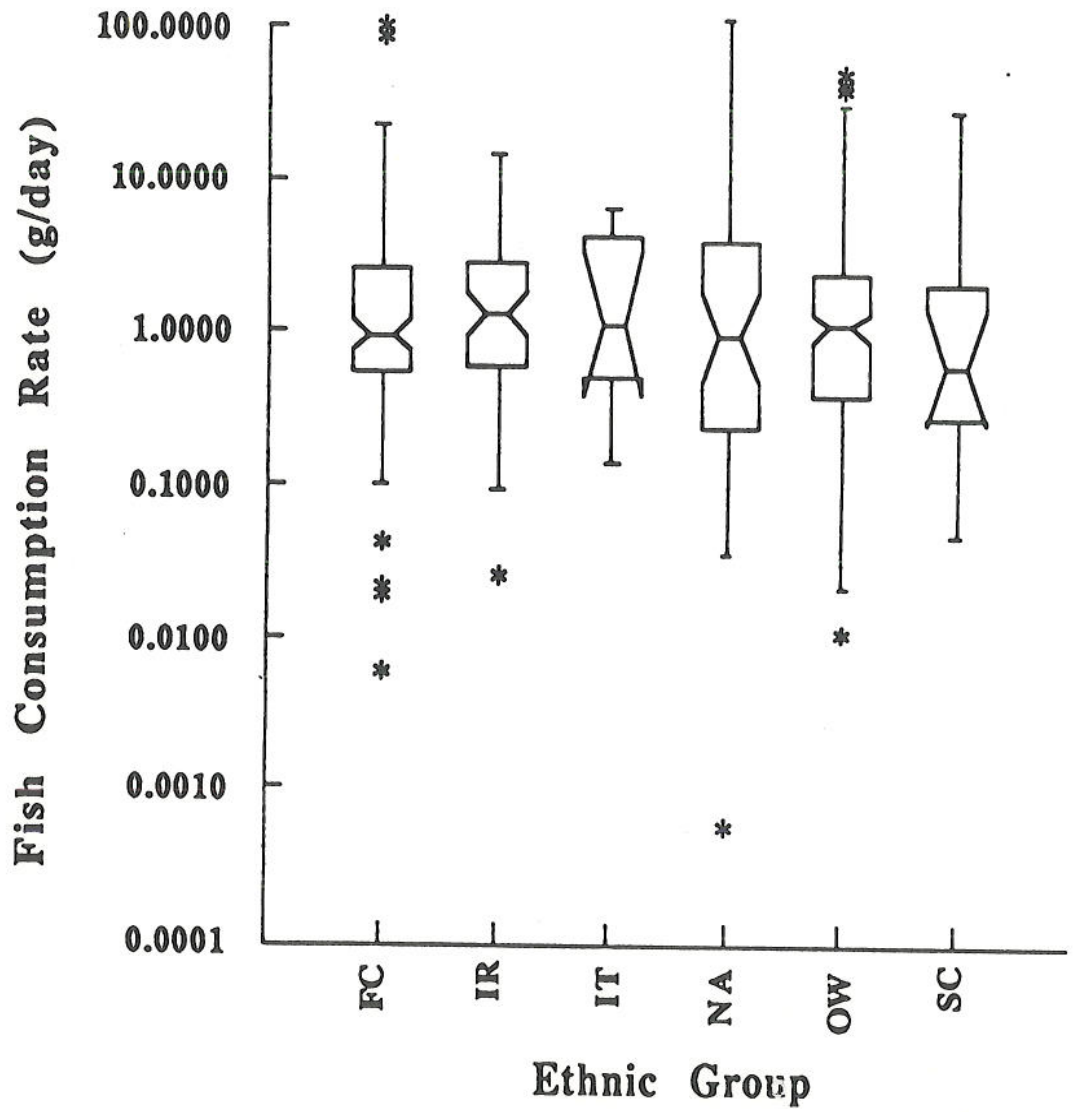


Figure 2.

## FRESHWATER FISH CONSUMPTION BY ETHNIC GROUPS: RIVERS AND STREAMS




LEGEND

FC = French Canadian, N=86
IR = Irish, N=63
IT = Italian, N=10
NA = Native American, N=43
OW = Other White Non-Hispanic, N=237
SC = Scandinavian, N=14

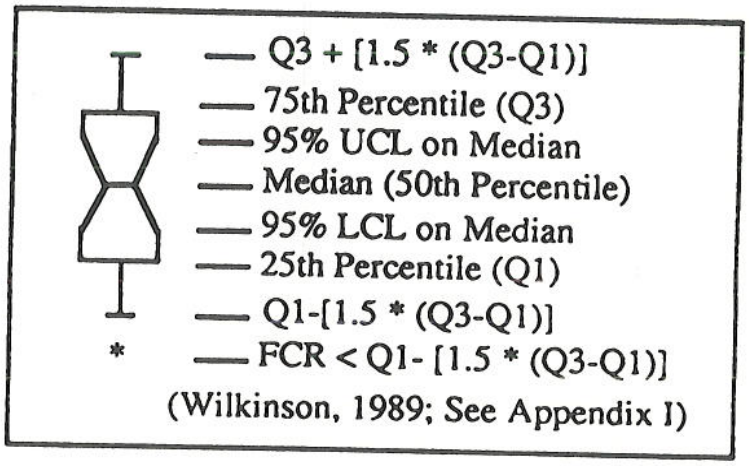


**Table 7. Distribution of Total Household Income Before Taxes in 1989**

| Income Level | No. of Households | % of Total Households Surveyed[a] |
|---|---|---|
| Under $10,000 | 173 | 11 |
| $10,000 to $19,999 | 323 | 20 |
| $20,000 to $29,999 | 319 | 20 |
| $30,000 to $39,999 | 256 | 16 |
| $40,000 to $49,999 | 198 | 12 |
| $50,000 to $59,999 | 105 | 6.5 |
| $60,000 to $69,999 | 47 | 2.9 |
| $70,000 to $79,999 | 24 | 1.5 |
| $80,000 to $99,999 | 24 | 1.5 |
| Over $100,000 | 20 | 1.2 |
| Did not answer | 123 | 7.6 |

a. Based on total number of respondents

Figure 3

# FRESHWATER FISH CONSUMPTION BY INCOME GROUPS: ALL WATERS

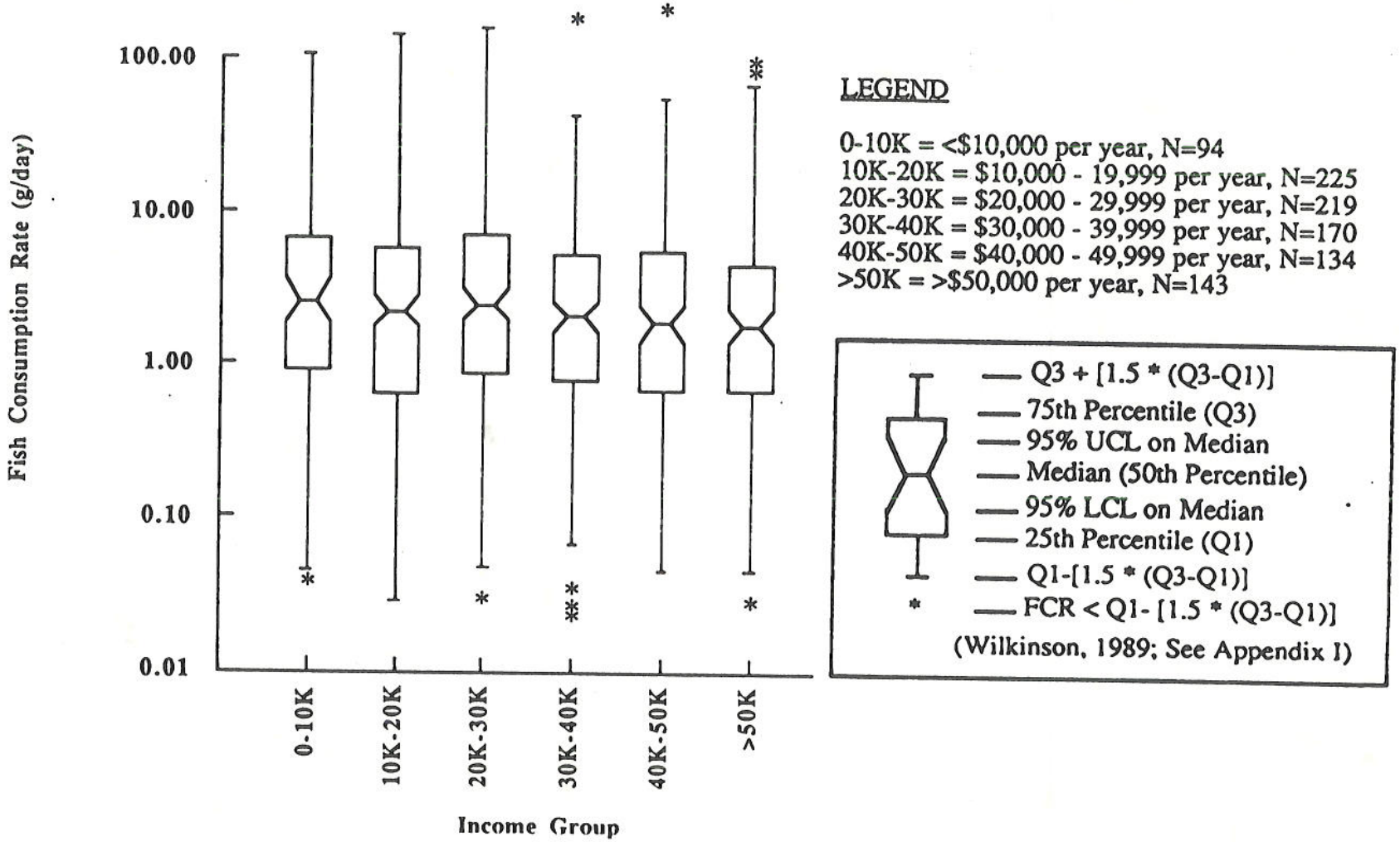
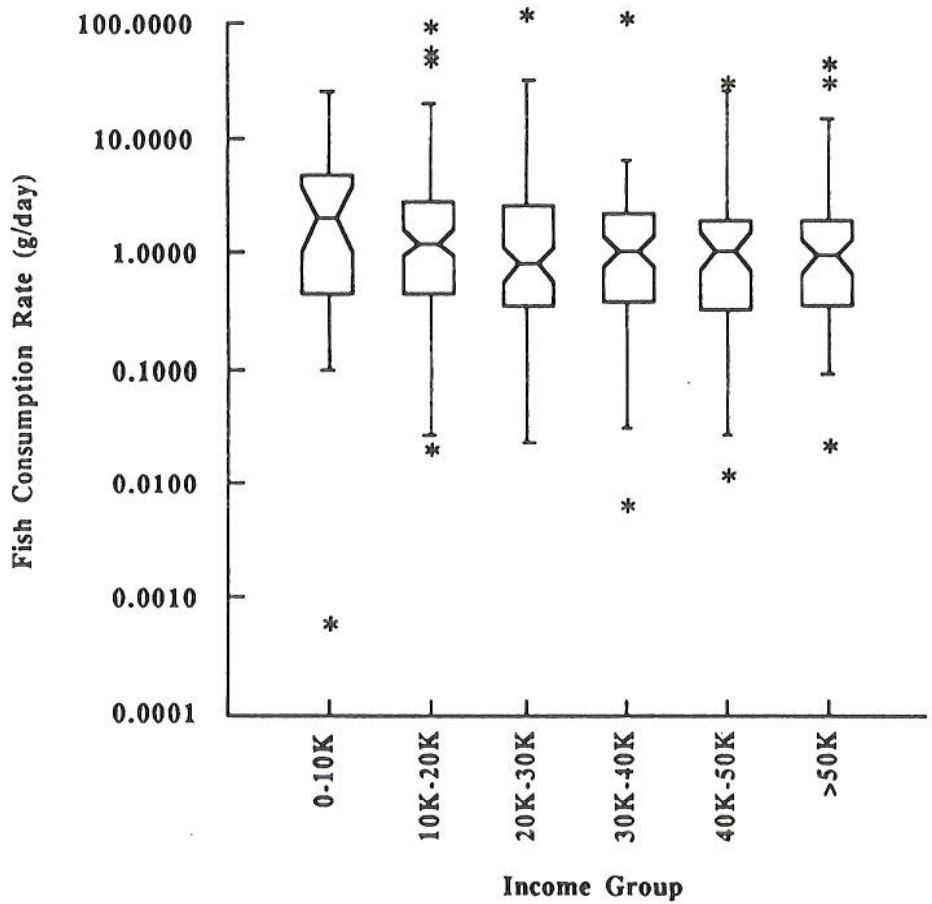


Figure 4

# FRESHWATER FISH CONSUMPTION BY INCOME GROUPS: RIVERS AND STREAMS




LEGEND

0-10K = <$10,000 per year, N=34
10K-20K = $10,000 - 19,999 per year, N=117
20K-30K = $20,000 - 29,999 per year, N=94
30K-40K = $30,000 - 39,999 per year, N=83
40K-50K = $40,000 - 49,999 per year, N=51
>50K = >$50,000 per year, N=64

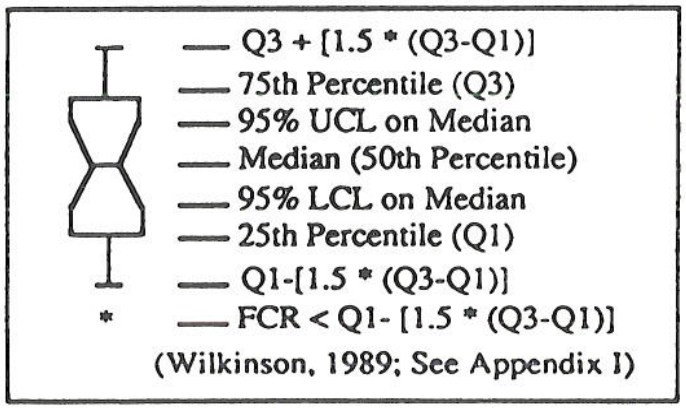


Table 8a. Analysis of Fish Consumption by Annual Household Income Levels: "All Waters"[a]

| | Consuming Anglers[b] | | | | | |
|---|---|---|---|---|---|---|
| | Less than $10,000 | $10,000 to $19,999 | $20,000 to $29,999 | $30,000 to $39,999 | $40,000 to $49,999 | Greater Than $50,000 |
| N of Cases | 94 | 225 | 219 | 170 | 134 | 143 |
| Median (50th percentile)[c,d] | 2.6 | 2.2 | 2.5 | 2.0 | 1.9 | 1.7 |
| 66th percentile[c,d] | 4.1 | 4.2 | 4.6 | 3.9 | 3.3 | 3.0 |
| 75th percentile[c,d] | 6.7 | 5.7 | 7.1 | 5.3 | 5.4 | 4.4 |
| Arithmetic Mean[c] | 7.6 | 6.6 | 7.5 | 5.3 | 6.2 | 6.7 |
| Percentile at the Mean[d] | 76 | 77 | 76 | 75 | 76 | 80 |
| 90th percentile[c,d] | 23 | 15 | 14 | 10 | 12 | 11 |
| 95th percentile[c,d] | 29 | 28 | 28 | 18 | 20 | 48 |
| Percentile at 6.5 g/day[d,e] | 72 | 77 | 74 | 84 | 76 | 79 |

a. "All Waters" based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.

b. "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.

c. Fish consumption rates are expressed in g/person-day and are the average consumption per day by freshwater fish consumers in the household. Fish consumption rates under "All Waters" are based on reported consumption from all Maine sources, and estimated consumption during 1990 after the survey was completed. Rates summarized under "Rivers and Streams" are based on reported consumption from rivers and streams, estimated consumption during 1990 after the survey was completed, and estimated consumption from other household and non-household sources attributable to rivers and streams.

d. Calculated by rank without any assumption of statistical distribution.

e. Fish consumption rate recommended by EPA (1984) for use in establishing ambient water quality standards.

Table 8b. Analysis of Fish Consumption by Annual Household Income Levels: "Rivers and Streams"[a]

| | Consuming Anglers[b] | | | | | |
|---|---|---|---|---|---|---|
| | Less than $10,000 | $10,000 to $19,999 | $20,000 to $29,999 | $30,000 to $39,999 | $40,000 to $49,999 | Greater Than $50,000 |
| N of Cases | 34 | 117 | 94 | 83 | 51 | 64 |
| Median (50th percentile)[c,d] | 2.0 | 1.2 | 0.78 | 1.0 | 1.0 | 0.93 |
| 66th percentile [c,d] | 2.7 | 2.0 | 1.4 | 1.7 | 1.7 | 1.3 |
| 75th percentile [c,d] | 4.8 | 2.8 | 2.5 | 2.2 | 1.9 | 1.7 |
| Arithmetic Mean [c] | 4.7 | 3.8 | 5.0 | 2.9 | 2.7 | 3.2 |
| Percentile at the Mean [d] | 74 | 79 | 89 | 81 | 78 | 83 |
| 90th percentile [c,d] | 21 | 6.1 | 6.2 | 3.9 | 5.7 | 9.1 |
| 95th percentile [c,d] | 22 | 11 | 14 | 5.4 | 9.6 | 14 |
| Percentile at 6.5 g/day [d,e] | 76 | 92 | 90 | 99 | 92 | 88 |

a. "Rivers and Streams" based on fish caught only from rivers and streams in Maine.
b. "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.
c. Fish consumption rates are expressed in g/person-day and are the average consumption per day by freshwater fish consumers in the household. Fish consumption rates under "All Waters" are based on reported consumption from all Maine sources, and estimated consumption during 1990 after the survey was completed. Rates summarized under "Rivers and Streams" are based on reported consumption from rivers and streams, estimated consumption during 1990 after the survey was completed, and estimated consumption from other household and non-household sources attributable to rivers and streams.
d. Calculated by rank without any assumption of statistical distribution.
e. Fish consumption rate recommended by EPA (1984) for use in establishing ambient water quality standards.

## 4.0 DISCUSSION

The EPA has stated that "whenever possible, data on local consumption patterns should be collected or obtained from a current database" (EPA, 1989b). This survey was undertaken in an effort to provide information on the freshwater fish consumption habits of Maine anglers. The results of this study provide the most accurate and only known characterization of freshwater fish consumption habits by Maine's anglers.

In this statewide mail survey, the median consumption rate for all anglers and for river anglers on flowing waters, including non-consumers, was 0 g/day while the median for consuming anglers on flowing waters was 0.99 g/day. For all waterbody types, the median for all anglers was 1.1 g/day and the median for consuming anglers only was 2.0 g/day. The mail survey results for flowing waters are supported by the results of two riverine creel surveys recently conducted in the State of Maine. The Saco River survey (ChemRisk, 1991a) indicated that the median rate of fish consumption by consuming anglers and their families was 1.2 g/day. A similar study of the West Branch of the Penobscot River (ChemRisk, 1991b) indicated that the median fish consumption rate for consuming anglers and their families from all surveyed reaches was 1.3 g/day.

It is important to note that because the fish consumption rates are positively skewed rather than symmetrically distributed, the arithmetic mean is not the most appropriate descriptive measure of the center of the distribution. For all anglers on all waters, the mean of 5.0 g/day corresponds approximately to the 79th percentile while the mean of 6.4 g/day for consuming anglers from all waterbodies corresponds to the 77th percentile. For flowing waters, the mean of 1.2 g/day for all anglers corresponds to the 85th percentile, the mean of 1.9 g/day for river anglers corresponds to the 83rd percentile, and the mean of 3.7 g/day for consuming river anglers corresponds to the 81st percentile.

The median, or 50th percentile, is a more physically relevant central tendency measure for a skewed dataset as 50 percent of consumption rate estimates lie above the median and 50 percent fall below the median. Thus, the median values provide the most representative consumption rate estimate for each of the angler populations. We have, therefore, defined the "typical individual" as that corresponding to the 50th percentile consumer.

It is likely that these fish consumption estimates are conservative due to assumptions made in the analysis. For example, a 40 percent assumption was used in this analysis to estimate the edible portion of landlocked and Atlantic salmon. As there is no specific edible portion data in the published literature, this was based on the results of a whole/edible portion study of landlocked salmon conducted on the West Branch of the Penobscot River (Ebert, 1991a) for which the mean edible portion was determined to be 37 percent. Because Atlantic salmon are the same species and are likely to be more muscular than landlocked salmon (Personal communication, J. Trial, 1991), the 95th upper confidence limit of 40 percent was used to estimate edible portion for these fish. This is extremely conservative as Atlantic salmon represented only 0.5 percent of the total fish mass consumed by resident anglers (Table 4). In addition, the edible portion of West Branch landlocked salmon is likely to be greater than that of landlocked salmon from other locations within the State because of a higher condition factor, i.e., the fish are fatter (Personal communications, J. Trial, E. Spear, 1991). Consequently, the use of an assumed edible portion of 40 percent for all salmon may substantially overestimate the actual mass of salmon consumed. Landlocked salmon comprised 17 percent of the total fish mass consumed by anglers.

Due to the inclusion of future trip estimates, it is likely that fish consumption rates, for those individuals reporting intended future trips, have been overstated. Question 25 of the survey asked anglers to estimate the number of days they expected to fish during the remainder of 1990. Although the open water fishing season on most waterbodies ends on September 30, limited fishing is allowed until October 15 or 30 on certain waterbodies. It was considered important that these future fishing trips be considered in the analysis. For the estimation of consumption, it was assumed that the intended number of future fishing trips would actually be taken. In addition, it was assumed that the average success and consumption rates for the individual angler during the trips already taken would continue through future trips.

It is likely that this approach overestimates the number of future fishing trips actually taken and the number of fish consumed as a result of those trips. Survey participants are likely to over-report the number of trips that will be taken in the future (Personal communication, K. Boyle, 1991). Factors like poor weather and unplanned other commitments may prevent anglers from initiating trips that they intended to take at the time of the survey. In addition, the availability of fish generally decreases in the Fall (personal communications, E. Spear, K.Boyle, O. Fenderson, 1991). Harvest rate (fish per trip) would, most likely, be lower in the Fall than during the summer months. Consequently, the contribution to total fish consumption represented by future trips

estimates very likely results in an overestimation of the total fish consumption rates for all waters and for flowing waters.

It is also likely that estimated fish consumption rates are over-reported due to survey biases. Chase and Harada (1984) have reported that participants responding to self-report surveys tend to overreport their actual participation in recreational activities. Similar results were reported by Soldat (1970) in his survey of Columbia River anglers. In a study done for the U.S. Fish and Wildlife Service, Westat, Inc. (1989) reported that a one-year recall period produced "substantial overestimates" of fishing statistics. Factors that can affect reporting include the length of the recall period, the frequency of the fishing trips, interest in or importance of the activity to the individual, and the perceived social desirability (prestige bias) of the activity. Similar biases have been reported in other studies of recreational activities (Ghosh, 1977; Chase & Godbey, 1983).

The length of recall period, the self-reporting nature of the survey, the social desirability of the sport, and the frequency of fishing trips are all contributing factors which are likely to result in overestimates of consumption. Avid anglers are likely to fish more frequently and experience a higher degree of success than less avid anglers. Thus, it can be assumed that avid anglers are among the highest consumers of freshwater fish. As overreporting appears to be correlated with skill level and importance of the activity to the individual, it is likely that the higher consumption rates may be substantially overstated.

It is likely that consumption of riverine fish has been further overestimated in this analysis due to the inclusion of smelt and adult Atlantic salmon. Neither of these species resides in Maine's rivers. Rather, they are found in Maine rivers only during their spawning runs. Their inclusion in consumption estimates is likely to overstate the consumption of riverine species.

The results of this survey indicate that the consumption of freshwater fish by Maine's anglers and their families is low. This is not surprising given the commercial and recreational availability of saltwater fish. The consumption rate estimates for the "typical individual" in each of the four groups of anglers and their families are all well below the EPA's (1984) recommended per capita estimate of 6.5 g/day. In fact, the EPA's estimate of 6.5 g/day represents the 96th percentile of consumption from this survey for all river anglers and the 92nd percentile of consuming river anglers.

This study demonstrates that a freshwater fish consumption rate of approximately 1 g/day is the most appropriate value for use in a risk assessment upon which to base a health-protective water quality standard for dioxin in the State of Maine. This estimate is based on information provided by Maine's resident anglers. Because consuming Maine anglers and their families are the highest consumers of Maine's freshwater fish, use of this consumption rate would be adequate to protect the health of Maine residents. This statewide mail survey provides convincing evidence that the use of a this fish consumption rate for standard-setting in Maine is appropriate and conservative.

## 5.0 REFERENCES

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